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Management efficiency in football: An empirical analysis of two extreme cases

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Abstract

Analysis of managerial efficiency in sport economics typically focuses on evaluating coach decisions instead of assessing the organization as a whole. This paper studies the relative importance of variables related to power and managerial decisions by estimating stochastic production frontiers models for the Chilean and Italian football. We find the presence of technical inefficiencies in both cases. However, managerial decisions play a more significant role in the Italian league. This difference can be explained by a less open and balanced competition in the Chilean case, that could be due to a lower demand and/or financial constraints faced by small clubs in that country.

Keywords: stochastic production frontier, managerial efficiency, sport economics.

JEL Classification: J44, L83, M50

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1. **Introduction**

The empirical analysis of the factors that determine technical inefficiencies in the sport industry has been a topic of intense research in the economic and sport literature; see Hofler and Payne (2006), Kahane (2005) and Simmons and Frick (2008). In these studies, the focus is mainly on the ability of one layer of management (the coach) to extract the best possible performance from the players given his budget (Kahane, 2005 and Simmons and Frick, 2008) or team strategy (Hofler and Payne, 2006) but not on the overall ability of the organization to transform its potential power over resources to the best possible outcome.

Estimating the overall efficiency of different organizations in dealing with their resources is relevant in the field of industrial organization. However, this is usually not an easy task, mainly because of the difficulties one has to face in order to obtain good proxies of some unobservable variables, such as "power" or "performance" of the different firms in a given industry. The analysis of sport results and its correlation with some features of the clubs that can be thought to be related to endowment provides a plausible answer to this issue. For example, Buraimo et al. (2007) report high correlation, for the 92 clubs in English professional football, between the potential of a club (as represented by variables capturing its geography and history) and both the club's revenue and its ranking in the league. This is also consistent with the central proposition of the most influential theoretical model in sports economics, the two team league model of El-Hodiri and Quirk (1971), that large market clubs will dominate small market clubs because they generate greater revenue and hire better players. For example, a club may be located in a large city and have won many trophies in the past. This 'big' club would therefore have a larger fan and revenue base that its rivals and greater power in the player labour market. If both clubs are managed efficiently, the 'big' club is expected to win more matches than the small club.

This paper is an empirical analysis on the presence of x-inefficiency in the top division of the Chilean and Italian football leagues through the estimation of stochastic production frontiers. According to the previous discussion, our econometric specification relates team performance to a set of power indicators (history and past results) while stochastic deviations of this function can be explained by managerial decision variables. Moreover, the comparative analysis of these two extreme cases, one a very modest league and the other amongst the most important in the world, is a novel aspect of our paper compared to related literature on sport, which usually focuses on a single national league. This comparison is especially interesting given that, compared to the Italian league, clubs in the Chilean league face a lower demand and are in principle more likely to be affected by financial restrictions that prevent them from achieving the highest possible performance.

We find evidence of technical inefficiencies in both the Chilean and the Italian leagues. However, an important difference is that, in the Italian league, a significant share of team performance is due to stochastic shocks related to the efficiency of club management; by contrast, stochastic elements do not play a significant role in the Chilean league. This difference can be explained by the presence of simpler and smaller clubs in the Chilean league that could be due to the different size of the market and/or to financial constraints faced by small clubs in that country.

In the next section of the paper, we provide some theoretical insights about the relationship between institutional complexity and managerial effort. Section 3 presents and describes the variables used in the analysis and Section 4 explains the econometric approach used to estimate the impact of resource variables and technical inefficiencies on output in the Chilean and Italian football and discusses the results of the estimation. Conclusions are drawn in Section 5.

2. Guidance from theory

In this section we develop intuition about the relationship between managerial effort and institutional complexity. In other to do this we assume the framework proposed by Paolini and Tena (2012), which is an extended version of two-team models in the field of sport economics [El-Hodiri and Quirk (1971), Haan et al. (2002) and Késenne (2007)].

In this framework there are two teams that play a series of matches against each other. Each of the teams has to simultaneously decide its level of capital and managerial effort in order to maximize its profit function. These two variables have a positive impact on revenue, as they increase the likelihood of winning but, on the other hand, it is increasingly costly for a team to augment its level of capital and managerial effort. The latter effect is more important because, while the revenue of the teams is bound and subject to decreasing returns, costs can undergo infinite growth. This is a common and realistic assumption in theoretical models and ensures the existence of an equilibrium level for both variables (see Mas-Collel et al. (1995), Chapter 5).

The model involves two key assumptions. The first is a negative relationship between managerial effort and institutional complexity. This is a plausible hypothesis given that it is logical to assume that the amount of effort required to run an institution is an increasing function of the institution's level of capital. The second is that the cost of capital for a given team is positively affected by the amount invested by its rival. The reason is that if a club invests heavily to attract star players, football fans and media attention, it will leave a smaller portion of the market for its rival.

In these conditions, the model's equilibrium states that 1) there is an optimal level of managerial effort for each team, given capital investment, and 2) the equilibrium levels of the two team's capital and managerial effort are inversely related. These statements are the natural consequences of our two assumptions concerning the negative relationship between effort and institutional complexity and the increasing cost of capital investment.

In this framework, it becomes interesting to analyse how managerial effort in each team reacts to changes in capital. For example, assume that one of the teams suddenly increases its capital. This will make capital more expensive for the rival team and it will then react by reducing its level of capital and increasing its managerial effort due to the negative relationship between these two variables. Significantly, this implies that teams with low capital, either because of reduced market size or financial market restrictions, will react by increasing their level of managerial effort.

According to this hypothesis, it is interesting to analyse the importance of managerial variables in two extreme cases, one in which the level of capital of different clubs is clearly constrained by the size of the market (the Chilean league) and another that involves large, complex teams (the Italian league). The model would predict that managerial effort would be greater and, therefore, managerial inefficiency less important in Chile than in Italy.

Of course, as discussed in the introduction, this analysis requires considering the total endowment of the teams. In our particular framework this is a much broader measure than the budget for players, which is very likely to be endogenously affected by performance expectations; more importantly, it does not include all the information available about the team’s capital. In professional football, this measure of capital is largely intangible as it includes branding. However, it is reasonable to assume that this intangible capital is highly correlated with a set of proxy variables that should include stadium capacity and the team’s history (see Buraimo et al. (2007)). Also included in the group of endowment variables is the size of the city, as an indicator of the potential number of team supporters. For example, the Nielsen Institute reports each Italian team's number of supporters ('tifosi') in Series A in 2008. The teams with the largest numbers of followers were Juventus, F.C. Internazionale di Milano, A.C. Milan and Roma, which belong to the three largest Italian cities: Turin, Milan and Rome. The teams with less supporters are from small cities such as Verona, Lecce and Siena. We do not have such detailed information for the Chilean league but it is typically won by a team from Santiago, the country's largest city.

3. Data on the Italian and Chilean football league.

Our season-level variables relate to the period from 1992/93 to 2007/08 in the case of Italy and from season 1993 to 2008 in the case of Chile. During the sample period, for the Italian Series A, there have been 18 teams before 2004/05 and 20 teams afterwards. Before season 2004/05 4 teams were promoted and relegated and 3 teams afterwards. The best 4 teams qualify for the Champions League while teams can qualify to the Europa League either by winning the Italian Cup or by ending up in the 5^{th} or 6^{th} position in the national league. In the case of Chile, the first division was composed of 16 teams until 2004 and, since then, 20, 19, 21 and 20 for seasons 2005, 2006, 2007 and 2008 respectively. Each season is composed of two competitions: Opening ('Apertura') and Closing ('Clausura'). The champion of each tournament and the best second ranked automatically qualified for the most important international competition at the club level in South America: Copa de America.

The following variables are considered in both cases

Output (performance) measure

(i) Number of points divided by the maximum available for the ith team in season t ($y_{i,t}$). Although during sample period the number of points awarded for a victory changed from two to three in season 1995/96 for the Italian league and 1996 for the Chilean league, to make the performance measure consistent across seasons we computed it on the basis of three points for a win throughout the whole period. A dummy variable is used in the estimation to represent the seasons when three points was actually employed as the change in incentives was likely to have influenced the pattern of results. Simmons and Frick (2008) followed a similar procedure for Germany.

Group I (variables related to resources)

(ii) International tournament ($x_{1,i,t}$): dummy that takes the value 1 when club i is playing in that season's European Champion League (Italy) or Copa de Libertadores (Chile) at season t.

(iii) Stadium capacity ($x_{2,i,t}$).

(iv) Population size of the city (where the team plays its home games) ($x_{3,i,t}$).

(v) Champion in previous years ($x_{4,i,t}$): a weighted sum of the number of national league trophies in the previous three years. The weights were $(1/t^2)$ where t was 1 for the previous season, 2 for the season before and 3 for the season before that.

(vi) Performance in previous years ($x_{5,i,t}$): a weighted measure of the inverse of the ranking of each team in each of the top division competitions in the preceding three years. Performance is equal to zero in case a team has been in the second division. Weights are defined similarly to the previous variable.

(vi) Capital city ($x_{6,i,t}$): a dummy variable that takes the value one when the team plays in the capital of the country, Santiago de Chile in the case of Chile and Rome in the case of Italy.

Group II (variables related to technical decisions)

(viii) Total number of players ($z_{1,t,t}$): total number of footballers in each squad.

(ix) Number of foreigners ($z_{2,i,t}$):: total number of foreigners for each club.

(x) % goalkeepers ($z_{3,i,t}$): share of goalkeepers in the squad.

(xi) % defenders ($z_{4,i,t}$): share of defenders in the squad.

(xii) % midfielders ($z_{5,i,t}$): share of midfielders in the squad.

(xiii) Number of high scoring players ($z_{6,i,t}$): number of players at each club who had scored more than twenty goals in the previous season. Note that this number of goals is an ad-hoc decision to account for the presence of potential outstanding scoring players in the team. Of course, this variable could be affected by many events that could not fixed through time such as injuries, the presence of international competitions at the club or national level and the number of teams in the league. However, it is difficult to takes all these events into account based on subjective appreciation and because of this we do not change the definition of this variable through the sample. We acknowledge this as a potential weakness of our analysis to be explored in future research.

(xiv) Manager quality ($z_{7,i,t}$): proportion of matches won during the career of the manager of the club prior to season t.

(xv) Manager experience ($z_{8,i,t}$): number of years that the coach of the team has been involved in managerial activities.

(xvi) Foreign manager ($z_{9\mathrm{i},t}$): a dummy variable that takes the value 1 when the manager is a foreigner and zero otherwise.

All these variables are collected at the beginning of the season to avoid potential endogeneity problems.

Table 1 displays some descriptive statistics. The average values for many of the variables are very similar in Italy and Chile. The most relevant differences between the two leagues can be observed in stadium capacity that on average takes higher values for the Italian football. Also, size of the city reveals that top division teams are more concentrated in the big cities for the Chilean football league (mainly in the capital Santiago de Chile) whereas in Italy there are top football teams in relatively small cities. This is the case for example of Atlanta, Livorno, Empoli, Siena and Udinense. Some important differences also relate to the number of foreign players and managers in the two countries. As expected, the Italian league attracts a higher number of foreigners.

[INSERT TABLE 1 AROUND HERE]

4. Empirical Results

The model of stochastic frontier production functions was initially developed by Aigner et al. (1977) and Meeusen and van den Broeck (1977) and extended to panel data by Battese and Coelli (1995). The standard specification for a set of firms indexed by i over a number of periods t can be represented as:

$$Y_{i,t} = \alpha + \beta' x_{i,t} + \left(v_{i,t} + \upsilon_{i,t}\right) i = 1, \ldots, N; t = 1, \ldots, T \quad (1)$$

where $Y_{i,t}$ is a measure of firm i's output at time t, $x_{i,t}$ is a vector of the inputs defined in the previous section and β is a vector of unknown coefficients to be estimated. A common practice in the literature is to take logs of variables $Y_{i,t}$ and $x_{i,t}$. However, here we do not apply this transformation of the dependent variable as it is already defined as a ratio (points divided by maximum possible points in a season)[2].

The remainder of the equation is an error term composed of two components: 1) $v_{i,t}$ is a random error term assumed to be

$iid\ N\left(0,\sigma_v^2\right)$; and 2) $\upsilon_{i,t}$ is a non-negative random error term that is assumed to be independent and following a normal distribution that is truncated at zero and $iid\ N\left(m_{i,t},\sigma_\upsilon^2\right)$ with mean inefficiency, $m_{i,t}$, modelled as a function of various firm-level factors. Specifically,

$$m_{i,t}=\delta' z_{i,t}+w_{i,t} (2)$$

where $z_{i,t}$ is a vector of technical decisions undertaken by firm i in period t and δ is another vector of coefficients to be estimated. The error term is assumed to be $iid\ N\left(0,\sigma_w^2\right)$ truncated at $-\delta' z_{i,t}$ for consistency with the assumption that $\upsilon_{i,t}$ is non-negative and truncated at zero.

The model presented in equations (1) and (2) is estimated following the maximum likelihood method proposed by Battese and Coelli (1993) and made available in Coelli's (1996) computer program FRONTIER 4.1. The parameter $\gamma=\left(\sigma_\upsilon^2\right)/\left(\sigma_v^2+\sigma_\upsilon^2\right)$ .takes values in $[0,1]$ and it is particularly important as it shows the proportion of the sum of the two error variances that is accounted by technical inefficiencies. When this parameter is not statistically different from zero then it is not possible to reject the null hypothesis of zero technical inefficiencies and the specification should be a standard panel data econometric procedure to estimate the production function.

As discussed in the introduction, since our focus is not specifically on coach but on the efficiency of the organization as a whole, the production frontier is not taken by relating performance to the quality of the playing staff at the club as proxied by its total wage bill. Another important reason for not including the wage bill in this study is that the size of the budget at each club was not available at all in the case of Chile; even for Italy, the figures for wage bills were probably unreliable - either because clubs had an incentive to misreport or simply because complex bonus arrangements make it hard to represent a club's financial commitment with a single summary figure[3]. Note also that, given their focus on coaching ability, the wage bill is properly taken as exogenous in the empirical models of Kahane (2005) and Simmons and Frick (2008) but its size will in fact be influenced by expected team performance that year.

Accordingly, our Group I explanatory variables, the $x_{i,t}$ in equation (1), seek to represent factors from the geography and history of the club that should, collectively, determine its power to command resources. The task of management in the organization is to translate power into output (points). Decisions are, of course, taken at a number of levels in the club. In the stylized club we have in mind, the owners (perhaps represented by the chairman) or other senior managers hire a coach. The coach is then co-opted into management and may well have some input in the recruitment of the playing staff with whatever budget has been made available (in some cases a director of football will play the primary role here). Errors of judgment may be made, for example, by the chairman (who may choose a lower quality coach to work with the more expensive players whom the club can then afford) or by the director of football (who may use his budget to hire a sub-optimal balance of stars and journeymen or international and local players). Poor decisions at any level of management will prevent the club from reaching the level of performance (in terms of league points) that should be possible given its power and status. In our specification of equation (2) above, the $z_{i,t}$ (the Group II variables) represent a selection of such technical decisions. Studying them would not yield any conclusions if the management team at every club operated with maximum efficiency because then each club would be achieving the level of sporting performance commensurate with its endowment of power.

Table 2 presents generalized likelihood-ratio tests of the null hypothesis, that the inefficiency effects are absent from the model and that decision variables are jointly insignificant. A general result for all the specifications is that inefficiency effects are highly significant in both the Italian and the Chilean leagues.

[INSERT TABLE 2 AROUND HERE]

Table 3 reports results from the estimation of the stochastic frontiers for the two leagues (for Italy, columns (2) to (4) relate to re-estimation in robustness tests reported below; the lead results are in column (1)). The core finding is from the estimation of γ that suggests a more important role of stochastic shocks in managerial decisions in the Italian compared to the Chilean league.

[INSERT TABLE 3 AROUND HERE]

Among the Group I variables, the results for Italy show that the size of the team's home city is indeed an important determinant of the level of achievement of a football club. However, the benefit from city size is mitigated by location in the capital city; this could reflect diminishing returns to city size in the sports sector (Buraimo et al., 2009) or the fact that, in the Italian context, the capital city usually hosts competing high level football clubs that split the market. Stadium capacity (for a given size of city) is shown to have a negative impact on performance. Possibly managers with a large number of seats to fill relative to the size of the local market will have to price tickets lower: with the inelastic demand claimed to prevail in sports markets in developed countries (Fort, 2006), this will imply depressed revenue compared with what would be expected given the size of the city. Results on these spatial variables are different in Chile. There population itself is not significant but location in Santiago de Chile assuredly is. This combination of results likely reflects that a high proportion of clubs are located in the capital and, given they all have the same value for city size, this will prevent the importance of population size per se from being detected in the estimation. In contrast to Italy, Chilean clubs have faced restrictions on their ability to finance stadium development and therefore it is unsurprising that stadium size is a positive predictor of performance in this case. While results on these spatial variables display contrasts between Italy and Chile, the history variables yield similar findings: a history of achievement raises performance in the current period. Again, this is consistent with the importance of market size as clubs that were successful in the past will have collected more supporters on the way to the present.

Our Group II variables test for effects from several individual categories of technical managerial decisions. The choice of coach is shown to matter substantially. For Italy, similar to Simmons and Frick (2008) for Germany, we find that the quality of the coach (as reflected in his career win-ratio) is important but his length of experience has no independent role. Since it is inefficiency that is being modelled, the negative sign indicates that clubs who employ a coach with a better than average career record tend to be the clubs which are more efficient in converting status to sporting performance. The same is found in Chile. One of several possible explanations is that decision takers at some clubs undervalue coaching relative to player inputs. Note that we do not include a variable to account for the influence of a new manager (compared to the one who finished the previous season). The reason is that for the Chilean league we do not have information about the manager of teams playing in the second division the previous year and here we show a similar estimation in both countries for the purpose of comparison. However, when we run a similar estimation of Italy, including this variable, there are not significant changes in our results; the proportion of error variance due to technical inefficiencies is still significant (0.928 with a t-value of 12.22) and the variable new manager exerts a negative impact (but not significantly different from zero) on performance. This result accords with previous analysis by Tena and Forrest (2008) using match level data, who suggest that a new manager has only a very small effect and then only for a small number of matches (scapegoat hypothesis).

Players' wages account for the largest part of expenditure by professional sports teams and it is clearly key that whatever budget is available is spent judiciously. One trade-off clubs face is between the number of players on the roster and the average quality of players (higher quality players are likely to be more expensive) and a striking feature from Table 3 is the very high variance in squad size. In both countries, clubs with a below average squad size appear to be more efficient than those who opt for fewer players. Perhaps the former enjoy greater success because of substitution of quality for quantity or it could be that players in a small squad benefit from getting more playing time. Of course, it is also (just) possible that clubs who employ a higher number of personnel understand that this lowers expected performance but accept the fact because they are risk averse and, for example, want to guard against the adverse consequences of an exceptional number of injuries. The same remark qualifies the finding that a higher number of goalkeepers in the squad (in Italy) appears to be associated with lower efficiency. But the ratios of defenders and midfielders are not significant explanatory variables in either country, so that there seems to be efficient decision taking across the clubs with respect to the balance of different categories of outfielder (notwithstanding that relative numbers display high variation across clubs).

As an additional robustness test we analyse the impact of including a new decision variable in the model, new coach, that is defined as a dummy variable that takes value one when the manager of the team at the beginning of the season is different from the one at the end of the previous season. In this case, we are obliged to drop observations from teams playing in the second division the previous year as information about this variable does not exist for teams in the Chilean league. Results of this estimation reflect that now the efficiency hypothesis is rejected in both cases because the Chilean league is particularly inefficient in replacing old managers. However, also in this case the proportion of variance due to technical inefficiencies (and also its associate t-statistics) is substantially larger in the Italian compared to the Chilean league.

From the results, a particularly tricky decision for football clubs (as will be the case for managers in other creative industries, such as opera or research) is the proportion of resources to be used on star performers. In football, these are usually successful strikers, defined here by the variable `number of high scoring players'. This attracts a negative coefficient estimate for both countries, implying that clubs who choose to employ none or only a small number will fail to reach the production frontier. The implication that some clubs undervalue genuine strikers is weakened, of course, if there are labour market imperfections that restrict their movement away from their current clubs.

The degree of efficiency shown by a club in the Italian League also appears to be associated with its propensity to recruit foreign players compared with other clubs. Just as Kahane (2005) demonstrated that clubs which displayed a reluctance to employ francophone ice hockey players tended to pay a price in terms of lower levels of performance, so here a club with a below average number of foreigners is shown to fare worse as a result. Recent papers have highlighted the beneficial effects of foreign players in increasing the probability of success of the national team (Alvarez et al., 2011 report this effect and attribute it to spillover effects that raise the ability level of domestic players) and in increasing the level of competitiveness in domestic leagues (Flores et al., 2010). However, no significant effect is found in Chile, probably because its weak league cannot attract quality foreign footballers who would provide better value than local players.

Broadly, the results of the model imply that, while historical and geographical variables intended to capture market size play their expected roles in both Italy and Chile, impacts from the pattern of technical decisions across clubs tend to have a generally lower magnitude in Chile. To test the robustness of these results, we analyze now the implications of two different set of experiments. These estimations are also shown in Table 3. More specifically, our first group of experiments refers possible distortions resulting from penalties imposed on clubs for illegal activities (mainly match fixing scandals) in the Italian league during seasons 2004/05, 2005/06 and 2006/07. We eliminate these three seasons from the sample and estimate the model again. Main results were also robust to this experiment.

The model was also estimated for different definitions of variables for the Italian case. More specifically, we consider a dummy variable that takes value 1 when the team is located in any of the biggest four Italian cities: Rome, Milan, Naples and Turin. Conclusions are not affected in either case and the null of managerial efficiency could be rejected in both instances at the 1% level.[4]

Another set of experiments relates to the inclusion of the size of the city. As discussed earlier, this is a controversial indicator as it is a proxy variable for market size. We experimented with some alternative definitions of market size such as the number of inhabitants in the city divided by the number of clubs however this variable turned out not significant in any case what suggests that, at least in the long run, the size of the market in a given city is not exogenously given but it could be stimulated by the competition of rival neighbour teams. We also studied if some alternative variables related not only to the number of citizens but also to income could have a significant impact on performance. More specifically, we run the baseline estimation but replacing the number of citizens by (1) income per-capita in the city and (2) total income in the city. Results of this estimation are reported in Table 4. Note that the main conclusions of the paper uphold and, interestingly, income per-capita (total income) is only significant for Chile (Italy). This suggests that the relevant market size indicator for a football team could be different for developed and developing countries. Indeed, it is plausible to assume that a minimum level of income is needed to become a football fan and, once this threshold is surpassed, football stops being a luxury good, so total demand largely depends on the number of potential supporters.[5]

[INSERT TABLE 4 AROUND HERE]

5. Concluding Remarks

This paper analyzes the relationship between resource inputs and managerial efficiency on firms by the estimation of stochastic production frontiers for the top divisions in Chilean and Italian football. Unlike previous research, we focus not only on coach efficiency but on the ability of the whole organization to transform its potential power over resources to the best possible outcome in terms of league points. Results indicate the presence of technical inefficiencies in both cases but technical inefficiencies play a more important role in the Italian League.

Future lines of research are suggested by this work. First, an important branch of the sport literature is devoted to study the factors that explain differences in competitive balance; see, for example, Butler (1995), Flores et al. (2010) and Horowitz (1997). Given that our results show how the impact of different variables on results performance depends on indicators of geography and history as well as managerial decisions undertaken by the clubs, it would be interesting to study the relative importance of these variables in order to explain differences in competitive balances for sport competitions. Besides, given that power indicators are not fixed in time but it could be affected by market fluctuations as well as changes in the regulations, the model provides insight about how manager effort and the structure of the competition will be affected by these changes. Regarding to this issue, it is expected that some of the highly indebted Italian teams will be affected by the UEFA's "Financial Fair Play". According to our estimation, this change will reduce the amount of investment and make the result of the Italian competition more dependent on power indicators.

Finally, it is critical to understand why the relative importance power depends on the structure of national competitions. Our results suggest that in smaller and simpler clubs power variables explain a more important share of results than in the case of clubs competing in top tournaments, while the opposite holds for managerial decision variables. Developing a theoretical model that provides an explanation for this result is an issue to be explored in future research.

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Table 1. Descriptive statistics

	Italy				Chile			
	Average	Variance	Min	Max	Average	Variance	Min	Max
Points divided by máximum	*0.472*	*0.020*	*0*	*0.851*	*0.471*	*0.017*	*0.144*	*0.833*
Capital	*0.138*	*0.119*	*0*	*1*	*0.395*	*0.240*	*0*	*1*
International tournament	*0.194*	*0.157*	*0*	*1*	*0.172*	*0.143*	*0*	*1*
Stadium capacity (scale 1/100000)	*0.005*	*0.000*	*0.001*	*0.008*	*0.003*	*0.000*	*0.001*	*0.053*
Size of the city (scale 1/1000.000)	*0.091*	*0.007*	*0.007*	*0.271*	*0.190*	*0.044*	*0.001*	*0.467*
Champion in previous years	*0.130*	*0.119*	*0*	*1.833*	*0.143*	*0.110*	*0*	*1.583*
Performance in previous years	*0.909*	*0.094*	*0.121*	*1.539*	*0.928*	*0.080*	*0.333*	*1.521*
Number of foreigners	*8.039*	*20.756*	*0*	*24*	*3.953*	*1.804*	*0*	*7*
Total number of players	*25.836*	*11.575*	*17*	*36*	*26.219*	*18.836*	*18*	*43*
% goalkeepers	*0.087*	*0.001*	*0.036*	*0.167*	*0.090*	*0.001*	*0.036*	*0.174*
% defenders	*0.326*	*0.002*	*0.174*	*0.448*	*0.306*	*0.003*	*0.136*	*0.48*
% midfielders	*0.370*	*0.003*	*0.227*	*0.538*	*0.376*	*0.004*	*0.214*	*0.545*
% forwards	*0.217*	*0.003*	*0.095*	*0.44*	*0.228*	*0.002*	*0.12*	*0.423*
Number of high scoring players	*1.190*	*0.639*	*0*	*4*	*0.974*	*1.301*	*0*	*7*
Manager quality	*0.374*	*0.021*	*0*	*0.697*	*0.310*	*0.032*	*0*	*0.705*
Manager experience	*2.224*	*2.772*	*1*	*13*	*3.957*	*14.653*	*0*	*17*
Foreign manager	*0.138*	*0.119*	*0*	*1*	*0.330*	*0.222*	*0*	*1*
New manager	*0.409*	*0.243*	*0*	*1*	*0.451*	*0.249*	*0*	*1*

Table 2. Tests of hypotheses for parameters of the inefficiency frontier in the Italian and Chilean Leagues

	Italy					Chile	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(1)**	**(5)**
Null Hypothesis: $H_0: \gamma = \delta_0 = \ldots = \delta_{11} = 0$							
Test statistic	181.99 (***)	215.49 (***)	183.52 (***)	183.70 (***)	133.04 (***)	39.33 (***)	32.21 (***)
Null Hypothesis: $H_0: \delta_0 = \ldots = \delta_{11} = 0$							
Test statistic	157.72 (***)	205.38 (***)	161.08 (***)	159.3 (***)	115.7 (***)	39.32 (***)	32.32 (***)

(1) Estimation including all teams in the top division. (2) Estimation excluding observations from seasons 2004/05, 2005/06 and 2006/07. (3) Estimation similar to (1) but variable 'Capital' refers to the capital of any Italian province. (4) Estimation similar to (1) but variable 'Capital' refers to any of the 4 biggest Italian cities. (5) Estimation similar to (1) but including the variable "new manager" in the estimation and dropping teams that were in the second division the previous year. ***, **, * denotes rejection at the 0.01, 0.05 and 0.10 significance level respectively.

Table 3. Stochastic Production Frontier Estimation for the Italian and Chilean League.

		Italy					Chile	
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(1)**	(5)
Intercept	β_0	0.788 (13.46) (***)	0.755 (24.74) (***)	0.788 (8.30) (***)	**0.790** **(8.91)** **(***)**	0.996 (5.41) (***)	0.359 (21.55) (***)	0.366 (10.74) (***)
3 points dummy	β_1	0.049 (3.23) (***)	0.051 (12.24) (***)	0.051 (3.33) (***)	0.051 (4.30) (***)	0.066 (3.52) (***)	0.038 (2.06) (***)	0.046 (2.43) (***)
Capital	β_2	-0.099 (-2.35) (***)	-0.069 (-1.73) (*)	0.004 (0.30)	0.010 (0.42)	-0.095 (-1.69) (*)	0.057 (4.04) (***)	-0.044 (-3.12) (***)
International tournament	β_3	0.008 (0.55)	0.002 (0.13)	0.013 (0.73)	0.013 (0.71)	0.013 (0.66)	0.047 (2.10) (***)	0.037 (1.93) (*)
Stadium capacity	β_4	-7.491 (-2.25) (***)	-7.113 (-2.95) (***)	-1.897 (-0.47)	-2.046 (-0.44)	-13.74 (-2.14) (***)	5.429 (3.09) (***)	4.769 (2.92) (***)
Size of city	β_5	0.732 (3.43) (***)	0.582 (2.52) (***)	0.243 (2.51) (***)	0.215 (1.99) (*)	0.79 (2.47) (***)	0.244 (0.58)	0.382 (0.80)
Champion in previous years	β_6	-0.011 (-0.68)	0.021 (1.23)	-0.008 (-0.42)	-0.009 (-0.54)	-0.02 (-1.15)	0.049 (2.05)	0.016 (0.71)
Performance in previous years	β_7	0.029 (1.78) (*)	0.027 (3.01) (***)	0.030 (1.99) (**)	0.028 (1.79) (*)	0.06 (1.85) (*)	0.058 (3.01) (***)	0.144 (4.78) (***)
Intercept	δ_1	0.290 (9.11) (***)	0.227 (5.49) (***)	0.305 (25.18) (***)	0.302 (14.71) (***)	0.50 (2.37) (***)	-0.038 (-0.61)	0.154 (0.81)
Number of foreign players	δ_2	-0.004 (-3.06) (***)	-0.004 (-3.75) (***)	-0.004 (-2.85) (***)	-0.004 (-2.73) (***)	-0.005 (-2.60) (***)	-0.008 (-1.67) (*)	-0.012 (-1.29)
Total number of players	δ_3	0.009 (5.46) (***)	0.010 (14.04) (***)	0.009 (5.16) (***)	0.009 (5.23) (***)	0.01 (4.39) (***)	0.007 (4.71) (***)	0.015 (5.77) (***)
% goalkeepers	δ_4	0.438 (2.37) (***)	0.226 (2.60)	0.499 (2.68) (***)	0.496 (2.55) (***)	0.57 (2.48) (***)	-0.125 (-0.70)	-1.004 (-1.76) (*)
% defenders	δ_5	0.016 (0.13)	0.112 (1.03)	0.019 (0.16)	0.019 (0.16)	0.03 (0.18)	0.077 (0.84)	-0.357 (-1.24)
% midfielders	δ_6	0.024 (0.24)	0.102 (1.16)	0.028 (0.27)	0.023 (0.23)	0.03 (0.20)	-0.125 (-1.36)	-0.448 (-1.88) (*)
Number of high scoring players	δ_7	-0.022 (-3.19) (***)	-0.028 (-4.48) (***)	-0.021 (-3.00) (***)	-0.021 (-3.24) (***)	-0.02 (-2.14) (***)	-0.018 (-2.79) (***)	-0.088 (-6.30) (***)
Manager quality	δ_8	-0.441 (-9.38) (***)	-0.527 (-13.95) (***)	-0.458 (-10.21) (***)	-0.458 (-9.79) (***)	-0.49 (-7.71) (***)	-0.099 (-2.83) (***)	-0.350 (-2.37) (***)
Manager experience	δ_9	-0.0003 (0.09)	0.002 (0.65)	0.0001 (0.04)	-0.0002 (-0.05)	-0.004 (-0.97)	0.004 (2.06) (***)	0.008 (1.82) (*)
Foreign manager	δ_{10}	0.016 (1.14)	0.020 (5.28) (***)	0.016 (1.09)	0.016 (1.07)	0.02 (1.12)	0.002 (0.17)	-0.052 (-2.29) (***)
New Manager	δ_{11}	—	—	—	—	-0.02 (-1.51) (*)	—	-0.078 (-3.16) (***)
Composed error variance	σ^2	0.006 (12.37) (***)	0.004 (28.14) (***)	0.006 (12.54) (***)	0.006 (22.52) (***)	0.006 (10.60) (***)	0.008 (11.72) (***)	0.011 (7.97) (***)
Proportion of error variance due to technical inefficiencies	γ	1.00 (8.14) (***)	1.00 (15.26) (***)	1.00 (86.13) (***)	1.00 (32.23) (***)	0.90 (9.91) (***)	0.00000001 (0.02)	0.308 (2.81) (***)
Log-likelihood		341.23	319.83	339.00	339.08	260.95	267.09	230.60
Observations		296	236	296	296	232	274	233

(1) Estimation including all teams in the top division. (2) Estimation excluding observations from seasons 2004/05, 2005/06 and 2006/07. (3) Estimation similar to (1) but variable 'Capital' refers to the capital of any Italian province. (4) Estimation similar to (1) but variable 'Capital' refers to any of the 4 biggest Italian cities. (5) Estimation similar to (1) but including the variable "new manager" in the estimation and dropping teams that were in the second division the previous year. t-values are shown between brackets. ***, **, * denotes rejection at the 0.01, 0.05 and 0.10 significance level respectively.

Table 4. Stochastic Production Frontier Estimation for different measures of city size.

		Italy		Chile	
		(1)	(2)	(1)	(2)
Intercept	β	0.76 (17.32) (***)	0.78 (9.28) (***)	0.38 (12.87) (***)	0.39 (21.49) (***)
3 points dummy	β	0.05 (2.83) (***)	0.05 (3.24) (***)	0.04 (2.24) (***)	0.04 (1.89) (*)
Capital	β	0.02 (1.09)	-0.06 (-1.65) (*)	0.05 (3.56) (***)	0.06 (3.91) (***)
International tournament	β	0.01 (0.71)	0.01 (0.53)	0.04 (1.84) (*)	0.04 (2.11) (**)
Stadium capacity	β	4.12 (1.37)	-2.90 (-1.07)	5.96 (3.95) (***)	5.00 (3.36) (***)
Size of city	β	0.000001 (0.71)	0.00002 (2.77) (***)	0.00001 (2.54) (***)	0.0003 (1.54)
Champion in previous years	β	-0.01 (-0.49)	-0.01 (-0.83)	0.03 (1.37)	0.04 (1.61)
Performance in previous years	β	0.03 (1.63)	0.03 (1.76) (*)	0.06 (2.88) (***)	0.07 (3.52) (***)
Intercept	δ	0.29 (4.60) (***)	0.28 (6.70) (***)	-0.20 (-1.32)	-0.14 (-0.97)
Number of foreign players	δ	-0.004 (-2.59) (***)	-0.004 (-2.57) (***)	-0.02 (-2.79) (***)	-0.02 (-2.87) (***)
Total number of players	δ	0.01 (5.22) (***)	0.01 (5.38) (***)	0.01 (5.43) (***)	0.01 (6.13) (***)
% goalkeepers	δ	0.45 (2.17) (***)	0.44 (2.26) (***)	-0.35 (-1.06)	-0.46 (-1.17) (*)
% defenders	δ	0.03 (0.21)	0.02 (0.18)	0.27 (1.23)	0.14 (0.63)
% midfielders	δ	0.04 (0.39)	0.03 (0.31)	-0.02 (-0.11)	-0.05 (-0.30)
Number of high scoring players	δ	-0.02 (-2.94) (***)	-0.02 (-3.04) (***)	-0.05 (-4.17) (***)	-0.04 (-3.19) (***)
Manager quality	δ	-0.45 (-8.98) (***)	-0.44 (-8.93) (***)	-0.18 (-3.43) (***)	-0.19 (-2.67) (***)
Manager experience	δ	0.0005 (-0.18)	0.0006 (-0.19)	0.01 (2.99) (***)	0.01 (3.29) (***)
Foreign manager	δ	0.01 (0.86)	0.01 (1.00)	-0.02 (-0.97)	-0.01 (-0.63)
Composed error variance	σ	0.01 (12.46) (***)	0.01 (12.75) (***)	0.01 (8.98) (***)	0.01 (9.55) (***)
Proportion of error variance due to technical inefficiencies	γ	1.00 (3.83) (***)	1.00 (1.86) (*)	0.11 (0.95)	0.10 (1.47)
Log-likelihood		337.34	340.43	272.71	271.23
Observations		296	296	274	274

All estimation includes the baseline specification. Estimation (1) considers per-capita income of the city and estimation (2) the total income of the city as the measure of city size.
***, **, * denotes rejection at the 0.01, 0.05 and 0.10 significance level respectively.

NOTES

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2 Note that this estimation would be consistent with the log transformation of a Cobb-Douglas functional form such as $\exp\left(Y_{i,t}\right)=\prod_{i=1}^{K}\left(\exp\left(x_{i,t}\right)\right)^{\beta_i}*\exp\left(v_{i,t}+\upsilon_{i,t}\right)$ where $x_{i,t}=1$ and β_i is the ith component of vector β .

3 In addition, distortions will result if high quality players are willing to accept a lower wage at a `big' club.

4 We also tried with an ad-hoc definition of capital for Italy: the city of Milan where two of the most important football teams play, Internazionale di Milano and A.C. Milan, however this variable was not significant at the conventional levels.

5 As a potential indicator of market size we also considered the ratio of city size over the number of teams in the city however this variables turned out to be not significant what suggests that at least in the long run the size of the market in a given city is not exogenously given but it could be stimulated by the competition of rival neighbor teams.

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